

# **FINANCIAL ASSISTANCE FUNDING OPPORTUNITY ANNOUNCEMENT**



**U.S. Department of Energy  
Golden Field Office**

## **Research and Development for On-Board Vehicular Hydrogen Storage**

**Funding Opportunity Number: DE-PS36-06GO96003P**

**Announcement Type: Modification**

**CFDA Number: 81.087**

<b>Issue Date:</b>	<b>03/27/2006</b>
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<b>Invitations for Final Applications Sent:</b>	<b>08/04/2006</b>
<b>Final Applications Due Date:</b>	<b>09/29/2006 11:59 PM EST</b>

DATE: May 11, 2006

FROM: James P. Damm, Contracting Officer

TO: All Prospective Applicants

SUBJECT: Amendment No. 002 to Funding Opportunity Announcement No. DE-PS36-06GO96003P, Research and Development for On-Board Vehicular Hydrogen Storage

The Funding Opportunity Announcement is amended as follows:

The purpose of this Amendment 002 is to clarify DOE's intent to allow applicants to apply for both Category 1 and Category 2 with the same application. The original language in the Announcement neither specifically allows nor prohibits applicants from applying to both categories simultaneously for the same project.

The requirements for applicants applying to both Category 1 and Category 2 with the same application are as follows: 1) the application must meet the requirements for both categories; and 2) the cover page of the application must clearly state the applicant's intent to apply for both categories and clearly state the applicable technical topic of the application.

In addition, this amendment clarifies that all applications will be evaluated using the same criteria, regardless of the category designation. The potential for an applicant to become a partner in a Center of Excellence will be considered by DOE only after selections are made and will have no affect on the evaluation and selection process.

The text in the original Announcement that has been added, pursuant to this Amendment 002, is highlighted in yellow in the attached revised Announcement document. All other parts of the Funding Opportunity Announcement remain unchanged.

## NEW REQUIREMENTS FOR GRANTS.GOV

### Where to Submit

Applications must be submitted through Grants.gov to be considered for award.

### Registration Requirements

There are several actions you must complete in order to submit an application through Grants.gov (e.g., obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number, register with the Central Contract Registry (CCR), register with the credential provider, and register with Grants.gov). See <http://www.grants.gov/GetStarted>. Use the Grants.gov Organization Registration Checklist at <http://www.grants.gov/assets/OrganizationRegCheck.doc> to guide you through the process. Designating an E-Business Point of Contact (EBiz POC) and obtaining a special password called an MPIN are important steps in the CCR registration process. Applicants, who are not registered with CCR and Grants.gov, should allow at least 14 days to complete these requirements. It is suggested that the process be started as soon as possible.

### Questions

Questions relating to the registration process, system requirements, how an application form works, or the submittal process must be directed to Grants.gov at 1-800-518-4726 or [support@grants.gov](mailto:support@grants.gov). Part VII of this announcement explains how to submit other questions to the Department of Energy (DOE).

### Application Receipt Notices

After an application is submitted, the Authorized Organization Representative (AOR) will receive a series of four e-mails. It is extremely important that the AOR watch for and save each of the emails. It may take up to two (2) business days from application submission to receipt of email Number 2. You will know that your application has reached DOE when the AOR receives email Number 4. You will need the Submission Receipt Number (email Number 1) to track a submission. The titles of the four e-mails are:

- Number 1 - Grants.gov Submission Receipt Number
- Number 2 - Grants.gov Submission Validation Receipt for Application Number
- Number 3 - Grants.gov Grantor Agency Retrieval Receipt for Application Number
- Number 4 - Grants.gov Agency Tracking Number Assignment for Application Number

After receipt of email Number 4, you can view your application at DOE's e-Center, <http://e-center.doe.gov>. A User Id and password are required. If you already have a User Id and password you do not need to re-register.

### VERY IMPORTANT – Download PureEdge Viewer

In order to download the application package, you will need to install PureEdge Viewer. This small, free program will allow you to access, complete, and submit applications electronically and securely. For a free version of the software, visit the following web site: <http://www.grants.gov/DownloadViewer>.

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## **PART I – FUNDING OPPORTUNITY DESCRIPTION**

### **A. INTRODUCTION**

The Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) is soliciting applications with the objective of supporting the President's Hydrogen Fuel Initiative in developing a pathway to a hydrogen economy. To support this initiative, this DOE Hydrogen Program Announcement seeks to fund the research and development of viable hydrogen storage technologies for on-board vehicular applications. DOE intends to provide financial support for this effort under authority of the Energy Policy Act of 2005, Public Law 109-58, in particular the Spark M. Matsunaga Hydrogen Act of 2005, Title VIII – Hydrogen.

In his January 2003 State of the Union Address, President Bush announced the Hydrogen Fuel Initiative – “so that America can lead the world in developing clean, hydrogen-powered automobiles.” Hydrogen storage technology – the ability to carry enough hydrogen on-board a vehicle to enable a greater than 300-mile vehicle range – is crucial to the success of the President's Initiative. At the present time, no existing hydrogen storage technology meets the challenging performance required to make hydrogen-powered automobiles competitive with traditional vehicles. New and innovative ideas are needed on a continuing basis and this is the motivation for this announcement. Projects funded through this announcement will be incorporated into the framework of The National Hydrogen Storage Project, which was initiated in April 2004.

### **B. BACKGROUND**

For transportation, the overarching technical challenge for hydrogen storage is how to store the amount of hydrogen required for a conventional driving range (greater than 300 miles), within the vehicular constraints of weight, volume, efficiency, safety, and cost. Durability over the performance lifetime of these systems must also be verified and validated and acceptable refueling times and hydrogen delivery flow rates must be achieved.

The goal of the DOE hydrogen storage activity is to fund the research and development of viable hydrogen storage technologies primarily for on-board vehicular applications. The major objectives for on-board vehicular hydrogen storage are:

- By 2010, develop and verify on-board hydrogen storage systems achieving 2 kWh/kg (6 wt.%), 1.5 kWh/Liter, and \$4/kWh.
- By 2015, develop and verify on-board hydrogen storage systems achieving 3 kWh/kg (9 wt.%), 2.7 kWh/Liter, and \$2/kWh.

See Table 1 in Appendix C for a complete list of the technical performance targets for on-board hydrogen storage systems. The technical targets for on-board hydrogen storage systems<sup>1</sup> were

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<sup>1</sup>See the following websites for details on the targets:  
[http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/freedomcar\\_targets\\_explanations.pdf](http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/freedomcar_targets_explanations.pdf) and  
<http://www.eere.energy.gov/hydrogenandfuelcells/mypp/>

established through the FreedomCAR partnership between DOE and the U.S. Council of Automotive Research (USCAR). The partnership was recently expanded to include the major energy companies and renamed the FreedomCAR and Fuel Partnership<sup>2</sup>. The key technical challenges are also described in Appendix C.

DOE has conducted a series of workshops to identify R&D needs and to assess priorities and strategies for on-board hydrogen storage. Based on the findings from these workshops, the DOE issued a “Grand Challenge” to the global scientific community for research in hydrogen storage in July 2003. This Grand Challenge called for the establishment of hydrogen storage Centers of Excellence in Metal Hydrides, Chemical Hydrogen Storage and Carbon-Based Materials, with multiple university, industry and federal laboratory partners. In addition, independent projects were solicited on new materials and concepts, off-board hydrogen storage systems, and analyses of life cycle cost, performance and environmental impact. Complementing the Grand Challenge, the DOE Office of Science issued a solicitation in 2004 for basic research to help overcome key hurdles in hydrogen production, storage and conversion. The new Centers of Excellence and independent projects, together with existing DOE hydrogen storage efforts, constitute the framework for the National Hydrogen Storage Project.

The original “Grand Challenge” solicitation launched in 2003 was planned for approximately \$150 million over 5 years, subject to appropriations, and forms the basis for the bulk of DOE’s current hydrogen storage activity. Including new awards in basic research from the DOE Office of Science, announced in 2005, the DOE “National Hydrogen Storage Project” includes roughly 40 universities, 15 companies and 10 federal laboratories. **This Program Announcement is for approximately 3 to 6 new projects to be selected to complement the “Grand Challenge” activities.**

A separate National Laboratory Call (DE-PS36-06GO96012), titled “Laboratory Call for Research and Development for On-Board Vehicular Hydrogen Storage,” offers opportunities for National Laboratories to submit applications as primary applicants. The two announcements are parallel to each other and projects will be evaluated and selected using the same criteria. The total funding ceiling for all new awards selected from both announcements will be \$6,000,000, with no predetermined division of funding between the two announcements. See Section III.C for information regarding an FFRDC as a team member under primary applicants.

## C. SCOPE OF ANNOUNCEMENT

The goal of the DOE hydrogen storage activity is to fund the research and development of viable hydrogen storage technologies primarily for on-board vehicular applications. Applications are requested in the following two categories:

**Category 1:** Projects are sought that are supportive of and complementary to the activities of any of the existing Hydrogen Storage Centers of Excellence in Metal

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<sup>2</sup> The FreedomCAR and Fuel Partnership includes U.S. Department of Energy, USCAR (DaimlerChrysler Corporation, Ford Motor Company and General Motors Corporation), BP America, ChevronTexaco, ConocoPhillips, ExxonMobil Corporation and Shell Hydrogen U.S.

Hydrides, Chemical Hydrogen Storage, and Carbon-Based Materials. Such projects must help establish important new technical approaches or capabilities not presently available at the Centers. A successful applicant may become a Center partner, provided that the applicant signs an existing non-disclosure agreement that has been signed by each of the existing Center partners. The appropriate Center must be clearly stated on the cover page of the application. If the work is applicable to more than one Center, then each applicable Center should be listed on the cover page.

Category 1 applicants are encouraged to research the ongoing Center work at [http://www.nrel.gov/basic\\_sciences/carbon\\_based\\_hydrogen\\_center.cfm](http://www.nrel.gov/basic_sciences/carbon_based_hydrogen_center.cfm); <http://www.ca.sandia.gov/MHCoE/>; <http://www.chscpublic.ua.edu/>; <http://www.eere.energy.gov/hydrogenandfuelcells/storage>; [http://www.hydrogen.energy.gov/annual\\_progress05.html](http://www.hydrogen.energy.gov/annual_progress05.html); [http://www.hydrogen.energy.gov/annual\\_progress04.html](http://www.hydrogen.energy.gov/annual_progress04.html); [http://www.hydrogen.energy.gov/annual\\_review05\\_report.html](http://www.hydrogen.energy.gov/annual_review05_report.html); and <http://www.eere.energy.gov/hydrogenandfuelcells>

**Category 2:** Applications are sought for independent research and development projects that address one of three technical topics: 1) Materials Discovery; 2) Engineering Science; or 3) Systems, Safety and Environmental Analyses. These three topics, as well as required cost share and technical objectives, are described in Appendix C. Research and development of cylindrical high pressure or liquid on-board storage tanks and off-board storage are not sought under this announcement and will not be reviewed. The appropriate topic must be clearly stated on the cover page of the application.

Appendix C discusses the technology topics for both Categories 1 and 2. The topics in Appendix C are the only eligible research areas under this announcement.

Applicants seeking to become a partner in a Center of Excellence should apply to Category 1. The appropriate Center should be clearly stated on the cover page of the application. If the work is applicable to more than one Center, then each applicable Center should be listed on the cover page.

Applicants not seeking to become a partner in a Center of Excellence should apply only to Category 2. The appropriate technical topic should be clearly stated on the cover page of the application.

Applicants may apply for both Category 1 and Category 2 with the same application, provided that the application meets the technical topic requirements for both categories as described in Appendix C. However, applicants should not submit separate applications for the same project under both categories. Applicants wishing to apply to both categories with the same application must state both the appropriate Category 1 Center of Excellence and the appropriate Category 2 technical topic on the cover page of their application. Category 1 applications will not be considered for an award under Category 2 unless the application clearly states the applicant's intention to apply for both categories with the same application.

For either category (or both), applicants may not submit an application that covers more than one technical topic, (i.e., separate applications must be submitted for separate technical topics).

It is intended that this Funding Opportunity Announcement will be issued on an annual basis, subject to congressional appropriations and direction. New projects will be selected each fiscal year based on technical merit review, program policy review and the availability of funds. Projects will typically be of 2 to 5-year duration. The overall project duration will be subdivided into two or more phases with overall project go/no-go decision points between the phases.

The required minimum cost share varies by technology topic as described in Appendix C.

The application process will include two phases -- a preliminary application phase and a final application phase. Only applicants who are favorably selected in the preliminary application phase will be eligible to submit final applications.

Applicants receiving an award under this announcement will be required to provide periodic reports and presentations to DOE. Refer to Section VI.C for further information.



## **PART II – AWARD INFORMATION**

### **A. TYPE OF AWARD INSTRUMENT**

DOE anticipates awarding cooperative agreements for Category 1 awards and grants for Category 2 awards under this program announcement. If it is determined that a cooperative agreement is the appropriate award instrument, the nature of the Federal involvement will be included in a special award condition (See Section VI.B.2, Statement of Substantial Involvement).

### **B. ESTIMATED FUNDING**

A separate National Laboratory Call (DE-PS36-06GO96012), titled “Laboratory Call for Research and Development for On-Board Vehicular Hydrogen Storage,” offers opportunities for National Laboratories to submit applications as primary applicants. The two announcements are parallel to each other and projects will be evaluated and selected using the same criteria. The total funding ceiling for all new awards selected from both announcements will be \$6,000,000, with no predetermined division of funding between the two announcements. See Section III.C. for information regarding an FFRDC as a team member under primary applicants.

Approximately \$1,000,000 to \$2,000,000 is expected to be available each fiscal year beginning in FY2007 for new awards under these parallel announcements. Approximately \$3,000,000 to \$6,000,000 in total is expected to be available for new awards under these announcements over the 2 to 5-year lifetime of the awards. The actual level of funding, if any, depends on the appropriations for this program.

### **C. EXPECTED NUMBER OF AWARDS**

DOE anticipates making 3 to 6 awards under this announcement depending on the size of the awards and availability of funding.

### **D. ANTICIPATED AWARD SIZE**

DOE expects to fund each award at \$400,000 to \$2,000,000 over 2 to 5 years. If requested levels are higher, applicants must justify the need for more funds. The awards will be incrementally funded, where the amounts available each fiscal year will vary depending on the funds available, number of awards, technical merit review and program policy review.

### **E. PERIOD OF PERFORMANCE**

DOE anticipates making awards that will run for up to 5 years. Projects will range from 2 to 5 years duration. The overall project duration, called a project period, will be subdivided into two or more phases, or “budget periods,” with overall project go/no-go decision points between the phases.

## **PART III - ELIGIBILITY INFORMATION**

### **A. ELIGIBLE APPLICANTS**

All types of domestic applicants are eligible to apply, except other Federal agencies, Federally Funded Research and Development Center (FFRDC) Contractors, and nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995.

Foreign participants will not be eligible as the prime applicant. However, foreign participants will be allowed as subrecipients to a domestic applicant provided that:

- The foreign subrecipient effort, in aggregate, shall not exceed 20% of the total estimated cost of the project, including the applicant's and the foreign subrecipient's portions of the effort.
- The technical approach is unique and is not duplicative of any work that DOE is currently funding.
- The technology developed must be made available in the United States.
- The foreign participant must provide at least 20% cost sharing for their own portion of the project.

### **B. COST SHARING**

#### **Research and Development - Category 1 and Category 2, Topics 1 & 2**

For applications using Federally Funded Research and Development Centers (FFRDCs) as a subrecipient, required cost sharing is 20% of the total project cost, where total cost is the sum of the Government share (including FFRDC contractor costs) and the recipient share of allowable costs. The recipient cost share must come from non-Federal sources. (See 10 CFR Part 600 for the applicable cost sharing requirements.)

For applicants not using FFRDCs as a subrecipient, required cost sharing is 20% of the total project cost, where total cost is the sum of the Government share and the recipient share of allowable costs. The recipient cost share must come from non-Federal sources. (See 10 CFR Part 600 for the applicable cost sharing requirements.)

#### **Analysis only - Category 2, Topic 3**

No cost sharing will be required for applications under Topic 3, Systems, Safety and Environmental Analyses.

### **C. OTHER ELIGIBILITY REQUIREMENTS**

#### **Federally Funded Research and Development Center (FFRDC) Contractors**

FFRDC applicants are not eligible for an award under this announcement, but they may be proposed as a team member subject to the following guidelines:

Authorization for non-DOE/NNSA FFRDCs. The Federal agency sponsoring the FFRDC contractor must authorize in writing the use of the FFRDC contractor on the proposed project and this authorization must be submitted with the application. The use of an FFRDC contractor must be consistent with the contractor's authority under its contract.

Authorization for DOE/NNSA FFRDCs. The cognizant contracting officer for the FFRDC must authorize in writing the use of a DOE/NNSA FFRDC contractor on the proposed project and this authorization must be submitted with the application. The following wording is acceptable for this authorization.

“Authorization is granted for the \_\_\_\_\_ Laboratory to participate in the proposed project. The work proposed for the laboratory is consistent with or complementary to the missions of the laboratory and will not adversely impact execution of the DOE/NNSA assigned programs at the laboratory.”

Value/Funding. The value of, and funding for, the FFRDC contractor portion of the work will not normally be included in the award to a successful applicant. Usually, DOE/NNSA will fund a DOE/NNSA FFRDC contractor through the DOE field work proposal system and other FFRDC contractors through an interagency agreement with the sponsoring agency.

Cost Share. The applicant's cost share requirement will be based on the total cost of the project, including the applicant's and the FFRDC contractor's portions of the effort.

FFRDC Contractor Effort. The FFRDC contractor effort, in aggregate, shall not exceed 50% of the total estimated cost of the project, including the applicant's and the FFRDC contractor's portions of the effort.

Responsibility. The applicant will be the responsible authority regarding the settlement and satisfaction of all contractual and administrative issues, including but not limited to, disputes and claims arising out of any agreement between the applicant and the FFRDC contractor.

## PART IV – APPLICATION AND SUBMISSION INFORMATION

### A. ADDRESS TO REQUEST APPLICATION PACKAGE

Application forms and instructions are available at Grants.gov. To access these materials, go to <http://www.grants.gov>, select “Apply for Grants,” and then select “Download Application Package.” Enter the CFDA and/or the funding opportunity number located on the cover of this announcement and then follow the prompts to download the application package. **Note:** You will not be able to download the application package unless you have installed PureEdge Viewer (See: <http://www.grants.gov/DownloadViewer>).

### B. CONTENT AND FORM OF PRELIMINARY APPLICATION

Preliminary applications are required. You must complete the SF 424, attach your preliminary application file in the block provided, and submit electronically through Grants.gov at [www.Grants.gov](http://www.Grants.gov).

The application process will include two phases – a preliminary application phase and a final application phase. Only applicants who are favorably selected in the preliminary application phase will be eligible to submit final applications.

You must complete the mandatory forms and any applicable optional forms in accordance with the instructions on the forms and the additional instructions below. **Files that are attached to the forms must be in Adobe Portable Document Format (PDF) unless otherwise specified in this announcement.**

#### 1. SF 424 - Application for Federal Assistance

**Complete this form first to populate data in other forms.** Complete all required fields in accordance with the pop-up instructions on the form. To activate the instructions, turn on the “Help Mode” (Icon with the pointer and question mark at the top of the form).

**Note:** The dates and dollar amounts on this form should pertain to the entire project period, not just the first year, first phase, or other subset of the project period.

#### 2. Other Attachments Form

Submit the following files with your application and attach them to the Other Attachments Form. Click on “Add Mandatory Other Attachment” to attach the Project Narrative.

##### **Project Narrative File**

This section should provide a clear description of the work to be undertaken and how you plan to accomplish it. It must be formatted to address each of the preliminary merit review criteria and sub-criteria listed in Section V.A.2. Provide sufficient information so that the reviewers will be able to evaluate the application in accordance with these merit review criteria. Do not include any Internet addresses (URLs) that provide information necessary to review the application. See Section VIII.D for instructions on how to mark proprietary information in the application.

The project Narrative file must be formatted to separately address each of the sections listed below. Each section must not exceed the specified page limitation when printed

using standard 8.5" by 11" paper with 1 inch margins (top, bottom, left, and right). The font must not be smaller than 11 point.

**The Project Narrative section must not exceed 7 pages, as prescribed below.**

Graphics and visual material, including charts, graphs, maps, photographs, and other pictorial presentations, must be included in the Narrative document and will be counted in the page limitation for this section. **NOTE: Any pages that exceed the specified maximum number of pages for any item will be removed and will not be considered during the evaluation.** Evaluators will review only the number of pages specified.

Save all the project component information in a single PDF file, named "Project.pdf," and click on "Add Mandatory Other Attachment" to attach.

The Narrative shall consist of the following sections, with page limits where indicated:

a) Cover Page (one-page limit)

The Narrative cover page must indicate the name and type of organization, the announcement number, the project title, and both the technical and business points of contact for the applicant, denoting the names, titles, addresses, telephone and facsimile numbers, and electronic mail addresses. The cover page should also identify the name and type of organization for key participants, along with names, titles, addresses, telephone and facsimile numbers, and electronic mail addresses of participant contacts. The category and technical topic must also be clearly stated on the cover page. Category 1 applicants should indicate which Center of Excellence they wish to join. If the work is applicable to more than one Center, then each applicable Center should be listed on the cover page. Category 2 applicants should indicate the specific technical topic from Appendix C. Applicants wishing to apply for both categories with the same application should indicate all of the above information on the cover page. Please note however that for either category (or both), applicants may not submit an application that covers more than one technical topic, (i.e., separate applications must be submitted for separate technical topics).

b) Technical Summary (one-page limit)

A one-page technical summary shall be included in the Narrative to describe the proposed project in technical terms and explain how the proposed project will work toward the achievement of the targets and objectives in Appendix C. The name of the applicant and title of the proposed project shall be indicated at the top of the summary page.

c) Technical Proposal (5-page limit)

The Technical Proposal portion of the Narrative for the preliminary application shall be structured in accordance with the sections indicated below. The applicant should specify the technical challenges being addressed and must address the issues listed below.

**Section I: Technical Concept and Impact**

- Describe the overall relevance and applicability of the technical concept and approach in addressing the technical challenges facing on-board hydrogen storage

- Address and quantify the degree to which the project will advance hydrogen storage technology for on-board vehicular applications toward the program's specific technical performance targets
- Describe the innovation of the proposed technology or methodology compared to previous and on-going work by others

#### **Section II: Work Plan**

- Describe the work plan, including a schedule, milestones and go/no-go decision points with the go/no-go decision criteria for the proposed project
- Address the experience of the Principal Investigator and the project team in performing research in this discipline or related areas; provide a brief description of the relevant facility capabilities

**Applicants must review Section V.A.2, Evaluation Criteria for Preliminary Applications, to be certain that all aspects of the evaluation criteria are adequately covered in the Technical Proposal.**

To avoid duplication of current DOE-sponsored research in the relevant topic areas, the following information regarding current projects has been made available:

- The Hydrogen Storage Program at <http://www.eere.energy.gov/hydrogenandfuelcells/storage>;
- The DOE Hydrogen Program Annual Progress Reports at [http://www.hydrogen.energy.gov/annual\\_progress05.html](http://www.hydrogen.energy.gov/annual_progress05.html) and [http://www.hydrogen.energy.gov/annual\\_progress04.html](http://www.hydrogen.energy.gov/annual_progress04.html);
- The DOE Hydrogen Program Annual Program Merit Review and Peer Evaluation Report at [http://www.hydrogen.energy.gov/annual\\_review05\\_report.html](http://www.hydrogen.energy.gov/annual_review05_report.html); and
- Target explanations at [http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/freedomcar\\_targets\\_explanations.pdf](http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/freedomcar_targets_explanations.pdf) and <http://www.eere.energy.gov/hydrogenandfuelcells/mypp/>

Category 1 applicants are encouraged to research the ongoing Center work at [http://www.nrel.gov/basic\\_sciences/carbon\\_based\\_hydrogen\\_center.cfm](http://www.nrel.gov/basic_sciences/carbon_based_hydrogen_center.cfm); <http://www.ca.sandia.gov/MHCoE/>; and <http://www.chscpublic.ua.edu>

#### **Summary of Required Forms/Files for Preliminary Application Phase**

Your preliminary application must include the following documents:

<b>Name of Document</b>	<b>Format</b>	<b>File Name</b>
Application, SF424	PureEdge Form	N/A
Other Attachments Form: Attach the following files to this form:	PureEdge Form	N/A
Project Narrative File	PDF	Project.pdf

## **C. CONTENT AND FORM OF FINAL APPLICATION**

Applicants that have been invited to submit a final application must complete the mandatory forms and any applicable optional forms in accordance with the instructions on the forms and the additional instructions below. **Files that are attached to the forms must be in Adobe Portable Document Format (PDF) unless otherwise specified in this Funding Opportunity Announcement.**

### **1. SF 424 - Application for Federal Assistance**

**Complete this form first to populate data in other forms.** Complete all required fields in accordance with the pop-up instructions on the form. To activate the instructions, turn on the “Help Mode” (Icon with the pointer and question mark at the top of the form).

**Note:** The dates and dollar amounts on this form should pertain to the entire project period, not just the first year, first phase, or other subset of the project period.

### **2. Other Attachments Form**

Submit the following files with your application and attach them to the Other Attachments Form. Click on “Add Mandatory Other Attachment” to attach the Project Narrative. Click on “Add Optional Other Attachment,” to attach the other files.

#### **Project Narrative File – Mandatory Other Attachment**

This section should provide a clear description of the work to be undertaken and how you plan to accomplish it. It must be formatted to address each of the final merit review criteria and sub-criteria listed in Section V.A.2. Provide sufficient information so that the reviewers will be able to evaluate the application in accordance with these merit review criteria. Do not include any Internet addresses (URLs) that provide information necessary to review the application. See Section VIII.D for instructions on how to mark proprietary information in the application.

The Project Narrative file must be formatted to separately address each of the sections listed below. Each section must not exceed the specified page limitation, if any, when printed using standard 8.5” by 11” paper with 1 inch margins (top, bottom, left, and right). The font must not be smaller than 11 point.

The Project Narrative must not exceed the page limits where indicated in the descriptions below. **NOTE: Any pages that exceed the specified maximum number of pages below for any item will be removed and will not be considered during the evaluation. Evaluators will review only the number of pages specified.**

Save all the Project Narrative information in a single PDF file, named “Project.pdf”, (except for letters of commitment and personnel resumes as noted below), and click on “Add Mandatory Other Attachment” to attach.

The Narrative shall consist of the following sections, with page limits where indicated in the descriptions below.



a) Cover Page (one-page limit)

The Narrative cover page must indicate the name and type of organization, the announcement number, the project title, and both the technical and business points of contact for the applicant, denoting the names, titles, addresses, telephone and facsimile numbers, and electronic mail addresses. The cover page should also identify the name and type of organization for key participants, along with names, titles, addresses, telephone and facsimile, and electronic mail addresses of participant contacts. The category and technical topic must also be clearly stated on the cover page. Category 1 applicants should indicate which Center of Excellence they wish to join. Category 2 applicants should indicate the specific technical topic from Appendix C. Applicants wishing to apply for both categories with the same application should indicate all of the above information on the cover page.

b) Table of Contents (no page limit)

The Narrative shall include a Table of Contents and page numbers corresponding to the elements outlined herein. The Table of Contents does not have a page limit.

c) Technical Summary (one-page limit)

A one-page technical summary shall be included in the Narrative to describe the proposed project in technical terms and to explain how the proposed project will work toward the achievement of the targets and objectives in Appendix C. The summary may contain information that is not releasable to the public. It is intended for use by technical evaluators. Please note that this summary is different than the Public Abstract File, described below as the next attachment, which should not contain any proprietary information. The name of the applicant and title of the proposed project shall be indicated at the top of the summary page.

d) Technical Proposal (10-page limit)

The technical proposal portion of the Narrative shall be structured in accordance with the following sections (the structure, order of contents, etc. within a section are at the discretion of the applicant). Graphics and visual material, including charts, graphs, maps, photographs, and other pictorial presentations, must be included in the Technical Proposal section and will be counted in the page limitation for this section. Lists of references for the document will not count against the page limit.

**Section I: Technical Concept**

- In the project overview, describe the goals, objectives, and how the proposed concept offers advantages over current emerging technologies and methodologies
- Describe the proposed technical concept and the research program that will investigate that technical concept
- Identify the key technical risk areas of the proposed concept and how they will be addressed
- Describe and quantify the potential of the proposed concept to advance the technology and to achieve DOE's specific technical performance targets for on-board storage systems

**Section II: Work Plan**



### **Statement of Objectives**

- Define the goals and objectives of the project
- Describe how the proposed work plan will successfully meet the project goals
- Describe the work breakdown structure, including task descriptions
- Describe major milestones and the timing of these major milestones
- Describe the technical and administrative deliverables that will be produced throughout the project, including the specific end result of each phase
- Describe overall project go/no-go decision points (e.g. achieving x wt% hydrogen storage material capacity) and timing of these go/no-go decisions, as well as the quantitative criteria for how these go/no-go decisions will be made

### **Project Management**

- Describe how the proposed project organization will facilitate project success
- Define the roles of the team members
- Describe the approach to managing the team and ensuring communication among team members
- Describe how project safety will be addressed, particularly handling of hydrogen and handling of potentially hazardous materials

## **Section III: Qualifications and Facilities**

### **Personnel and Organization Qualifications**

- Describe the education, professional training, technical skills, and work experience of the Principal Investigator (PI) and other key personnel, including personnel from major subcontractors
- Describe the level of time commitment of the PI and other key personnel, including personnel from major subcontractors, assigned to the proposed project
- Address the capability of the proposed team to address all aspects of the proposed work
- Describe the relevant experience of each organization on the proposed team in performing similar projects

### **Facilities**

- Describe the applicant's existing facilities, and those of subcontractors, proposed for completing the work
- Describe any request for new facilities or equipment

#### **e) Resources by Task (5-page limit)**

The Narrative shall include a summary of resources by Statement of Objectives task. The summary must include the following for the applicant and each participant:

- The job title and estimated number of hours for each of the key personnel proposed by task
- The estimated travel budget by task; the travel budget should include costs for up to two investigators for travel to Washington, DC twice per year for project reviews
- The total proposed equipment, materials, and supplies budget by task

**Applicants must also review Section V.A.2, Evaluation Criteria for Final Applications, to be certain that all aspects of the evaluation criteria are adequately covered in the Technical Proposal.**

#### **Public Abstract File**

The public abstract must contain a summary of the proposed activity suitable for dissemination to the public. It should be a self-contained document that identifies the name of the applicant, the project director/principal investigator(s), the project title, the objectives of the project, a description of the project, including methods to be employed, the potential impact of the project (i.e., benefits, outcomes), and major participants (for collaborative projects). This document must not include any proprietary or sensitive business information as the Department may make it available to the public. The Public Abstract must not exceed 1 page when printed using standard 8.5" by 11" paper with 1" margins (top, bottom, left and right) with font not smaller than 11 point. Save this information in a file named "Abstract.pdf," and click on "Add Optional Other Attachment" to attach.

#### **SF 424 A Excel, Budget Information – Non-Construction Programs File**

You must provide a separate budget for each year of support requested and a cumulative budget for the total project period. Use the SF-424A Excel, "Budget Information – Non Construction Programs" form on the Applicant and Recipient Page at <http://grants.pr.doe.gov>. You may request funds under any of the Object Class Categories as long as the item and amount are necessary to perform the proposed work, meet all the criteria for allowability under the applicable Federal cost principles, and are not prohibited by the funding restrictions in this announcement (See Section IV.G). Save the information in a single file named "SF424A.xls," and click on "Add Optional Other Attachment" to attach.

#### **Commitment Letters from Third Parties Contributing to Cost Sharing File**

If a third party, (i.e., a party other than the organization submitting the application) proposes to provide all or part of the required cost sharing, the applicant must include a letter from the third party stating that it is committed to providing a specific minimum dollar amount of cost sharing. The letter should also identify the proposed cost sharing (e.g., cash, services, and/or property) to be contributed. Letters must be signed by the person authorized to commit the expenditure of funds by the entity. Provide this information in a single file named "CLTP.pdf" and click on "Add Optional Other Attachment" to attach.

#### **Personnel Resumes**

The application should include resumes for key personnel of the applicant and major participants. This file must be submitted in PDF format. This file should be included as an attachment file rather than with the narrative file (these resumes will not count against

the page limit). Provide this information in a single file named "Resumes.pdf" and click on "Add Optional Other Attachment" to attach.

**Reference Checks on Federal Awards**

Provide the information below for at least five, and no more than eight, federal awards that were received by either your organization or principal investigator in the last five years for technologies relevant to this announcement, with award values in excess of \$500,000. If applicant has fewer than five awards meeting this criteria, first submit those that meet the criteria, and for the remainder, provide information for federal awards over \$500,000 received by either the organization or principal investigator for all technologies in the last five years.

The following information is required for each federal award: 1) AWARD TITLE; 2) INSTRUMENT NUMBER; 3) TOTAL AWARD VALUE (\$); 4) PERIOD OF PERFORMANCE (Dates); 5) APPLICANT'S PROJECT DIRECTOR (Name, Address, Telephone Number [including area code]); and 6) FEDERAL AGENCY MAKING AWARD (Agency Name, Federal Program Manager, Federal Program Manager's Address, Federal Program Manager's Telephone Number [including area code]).

**Summary of Required Forms/Files for Final Application Phase**

Your application must include the following documents for the final application phase:

Name of Document	Format	File Name
Application for Federal Assistance – SF424	PureEdge Form	N/A
Other Attachments Form: Attach the following files to this form:	PureEdge Form	N/A
Project Narrative File	PDF	Project.pdf
Public Abstract File	PDF	Abstract.pdf
SF 424A File - Budget Information for Non-Construction Programs	Excel	SF424A.xls
Commitment Letters from Third Parties Contributing to Cost Sharing, if applicable	PDF	CLTP.pdf
Personnel Resumes	PDF	Resumes.pdf
Reference Checks on Federal Awards	PDF	RefChecks.pdf

## D. SUBMISSIONS FROM SUCCESSFUL APPLICANTS

Successful applicants must submit the information listed below not later than 60 calendar days after notification of selection. Applicants who fail to provide the information within the required time period may be eliminated from further consideration.

What to submit after selected	Required Form or Format
Designated Responsible Employee for complying with national policies prohibiting discrimination. Provide organization name, project title, DOE application tracking number and the name, title, and phone number of Designated Responsible Employee for complying with national policies prohibiting discrimination (See 10 CFR 1040.5).	E-mail information to: ricky.newton@go.doe.gov
Environmental Checklist	To be submitted at <a href="https://www.eere-pmc.energy.gov/nepa.asp">https://www.eere-pmc.energy.gov/nepa.asp</a>
Statement of Project Objectives	Forms are located at <a href="https://www.eere-pmc.energy.gov/forms.asp">https://www.eere-pmc.energy.gov/forms.asp</a>
Cost Reasonableness Determination for Financial Assistance (A cost reasonableness determination will also be required for major subrecipients.)	
Financial Assistance Pre-Award Information Sheet	
Disclosure of Lobbying Activities, SF-LLL, if applicable	
Representation of Limited Rights Data and Restricted Software	
Assurance of Compliance Nondiscrimination in Federally Assisted Programs	
Certifications Regarding Lobbying; Debarment, Suspension and Other Responsibility Matters; and Drug-Free Workplace Requirements	
Indirect Rate Agreement or a Rate Proposal	

## E. SUBMISSION DATES AND TIMES

### 1. Preliminary Application Due Date

Preliminary Applications must be received by **June 7, 2006**, no later than 11:59 PM Eastern Time. You are encouraged to transmit your application well before the deadline.

**Applications received after the deadline will not be reviewed or considered for award.**

### 2. Invitations for Final Applications

Successful preliminary applications will receive invitations to submit a final application. These letters will be sent by **August 4, 2006**.

### 3. Final Application Due Date

The Final applications must be received by **September 29, 2006**, no later than 11:59 PM Eastern Time. You are encouraged to transmit your application well before the deadline. **Applications received after the deadline will not be reviewed or considered for award.**

## F. INTERGOVERNMENTAL REVIEW

This program is not subject to Executive Order 12372 – Intergovernmental Review of Federal Programs.

## G. FUNDING RESTRICTIONS

Cost Principles. Costs must be allowable in accordance with the applicable Federal cost principles referenced in 10 CFR Part 600.

Pre-award Costs. Recipients may charge to an award resulting from this announcement pre-award costs that were incurred within the ninety (90) calendar day period immediately preceding the effective date of the award, if the costs are allowable in accordance with the applicable Federal cost principles referenced in 10 CFR part 600. Recipients must obtain the prior approval of the contracting officer for any pre-award costs that are for periods greater than this 90 day calendar period.

Pre-award costs are incurred at the applicant's risk. DOE is under no obligation to reimburse such costs if for any reason the applicant does not receive an award or if the award is made for a lesser amount than the applicant expected.

## H. OTHER SUBMISSION AND REGISTRATION REQUIREMENTS

### 1. Where to Submit

**Applications must be submitted through Grants.gov to be considered for award.**

Submit electronic applications through the "Apply for Grants" function at [www.Grants.gov](http://www.Grants.gov). If you have problems completing the registration process or submitting your application, call Grants.gov at 1-800-518-4726 or send an email to [support@grants.gov](mailto:support@grants.gov).

### 2. Registration Process

You must complete the registration process (all steps) before you can submit your first application through Grants.gov (See [www.grants.gov/GetStarted](http://www.grants.gov/GetStarted)). **We recommend that you start this process at least two weeks before the application due date.** It may take 14 days or more to complete the entire process. Use the Grants.gov Organizational Registration Checklists at <http://www.grants.gov/assets/OrganizationRegCheck.doc> to guide you through the process. **Important:** During the CCR registration process, you will be asked to designate an E-Business Point of Contact (EBIZ POC). The EBIZ POC must obtain a special password called "Marketing Partner identification Number" (MPIN).

## PART V - APPLICATION REVIEW INFORMATION

### A. CRITERIA

#### 1. Initial Review Criteria

Prior to a comprehensive evaluation, an initial review of the applications will be performed by the DOE Golden Field Office (GO) to determine the following: 1) the applicant is eligible for an award; 2) the information required by the announcement has been submitted; and 3) the minimum required cost share for the particular technical topic has been proposed. If an application fails to meet these requirements, it may be deemed non-responsive and eliminated from further review.

#### 2. Merit Review Criteria

##### **EVALUATION CRITERIA FOR PRELIMINARY APPLICATIONS**

The following evaluation criteria will be used in the comprehensive evaluation of preliminary applications. For each criterion, the weighting (out of a total of 100%) is indicated to show the relative importance.

##### **a) Technical Concept and Impact (Weight: 70%)**

- The overall relevance and applicability of the technical concept and approach in addressing the technical challenges facing on-board hydrogen storage
- The quantitative degree to which the project will advance hydrogen storage technology for on-board vehicular applications toward the program's technical performance targets
- The innovation of the proposed technology or methodology compared to similar previous and on-going work by others

##### **b) Work Plan (Weight: 30%)**

- Appropriateness of the work plan, schedule, milestones, go/no-go decision points and go/no-go decision criteria for the proposed project
- Experience of the Principal Investigator and the project team in performing research in this discipline or related areas; the adequacy of the relevant facilities

For successful preliminary applicants, scores and rankings under the preliminary review will be discarded and will not be used for evaluation of the final applications.

##### **EVALUATION CRITERIA FOR FINAL APPLICATIONS**

The following evaluation criteria will be used in the comprehensive evaluation of **final** applications. For each criterion, the weighting (out of a total of 100%) is indicated to show the relative importance.

##### **a) Technical Concept (Weight: 60%)**

- The relevance of the technical concept to the technical objectives of the announcement; the extent to which the proposed concept offers advantages over current emerging technologies and methodologies

- The feasibility of the proposed technical concept and soundness of the research program
- The identification of the key technical risk areas of the proposed concept and how the applicant plans to address them
- The potential of the proposed concept to advance the technology and to achieve DOE's specific technical performance targets for on-board storage systems

**b) Work Plan (Weight: 25%)**

**Statement of Objectives**

- The relevance and clarity of the goals and objectives of the project
- The likelihood of success of the proposed work plan to meet the project goals
- The clarity, adequacy and reasonableness of the work breakdown structure and task descriptions
- The adequacy, clarity and timing of major milestones
- The clarity and adequacy of technical project deliverables, including the specific end result of each phase of the project; the extent to which the deliverables will advance the state-of-the art
- The adequacy, clarity and timing of go/no-go decision points (e.g. achieving x wt% hydrogen storage material capacity) as well as the quantitative criteria for how these go/no-go decisions will be made

**Project Management**

- The adequacy of the proposed project organization to facilitate project success
- The clarity and appropriateness of the roles of the team members
- The approach to managing the team and ensuring communication among team members
- Adequately addresses safety, particularly handling of hydrogen and handling of potentially hazardous materials

**c) Qualifications and Facilities (Weight: 15%)**

**Personnel and Organization Qualifications**

- The adequacy of the education, professional training, technical skills, and work experience of the Principal Investigator (PI) and other key personnel, including personnel from major subcontractors
- The level and reasonableness of the time commitment of the PI and other key personnel, including personnel from major subcontractors, assigned to the proposed project
- The capability of the proposed team to address all aspects of the proposed work
- The relevant experience of each organization on the proposed team in performing similar projects

#### **Facilities**

- The adequacy of the applicant's existing facilities, and those of subcontractors, proposed for completing the work
- The reasonableness of any request for new facilities or equipment

For the final application, the proposed cost elements will not be point scored or adjectivally rated. However, they will be evaluated to determine if the total proposed amount is commensurate with the proposed effort.

### **3. Other Selection Factors**

The selection official will consider the following program policy factors in the selection process:

- Selection of applications to achieve a balance of complementary projects, in conjunction with existing projects funded by the DOE Hydrogen Program, to meet the overall goals and objectives of that Program
- Selection of projects involving a diversity (types and sizes) of proposing organizations and technologies
- Selection of applications with comparatively significant cost/benefit advantages
- Selection of applications with applicant cost share above the minimum level required
- Geographic distribution of applicants within the U.S.
- Past performance of applicants on previous Federal awards

## **B. REVIEW AND SELECTION PROCESS**

### **1. Merit Review**

Applications that pass the initial review described in Section V.A.1 will be subject to a merit review of the applications in accordance with the guidance provided in the "Department of Energy Merit Review Guide for Financial Assistance and Unsolicited Proposals." This guide is available under Financial Assistance, Regulations and Guidance at <http://professionals.pr.doe.gov/ma5/ma-5web.nsf/?Open>.

After passing the initial review, preliminary applications will undergo a preliminary merit review process where applications are evaluated and scored according to the Evaluation Criteria for Preliminary Applications listed in Section V.A.2 above. Selected preliminary applicants will then be notified by letter of the favorable results of the preliminary merit review and will be encouraged to submit a final application. Unsuccessful preliminary applicants will also be notified by letter of the results of the preliminary merit review and will be eliminated from further consideration. Only applicants who are favorably selected in the preliminary application phase will be eligible to submit final applications. Final applications will then be evaluated, scored, and ranked according to the Evaluation Criteria for Final Applications listed in Section V.A.2 above by a final objective merit review committee. The final merit review committee will make recommendations to the Selection Official as to



whether or not each final application is determined to be worthy of funding based exclusively on the technical strengths and weaknesses of the application.

Applications for Category 1 and for Category 2 (and for both) will be evaluated using the same criteria, regardless of category designation. The potential for an applicant to become a member in a Center of Excellence will be considered by DOE only after selections are made and will have no bearing on the evaluation and selection process. The technical evaluation criteria and program policy factors are identical for both categories.

## **2. Selection**

The Selection Official will consider the merit review recommendation, program policy factors, and the amount of funds available in making selection decisions.

## **3. Notice of Selection and Debriefings**

DOE will notify applicants selected for award. This notice of selection is not an authorization to begin performance. (See Section IV.G with respect to the allowability of pre-award costs.)

Organizations whose applications have not been selected will be advised as promptly as possible. For applicants who do not pass the initial review, this notice will consist of the findings of the initial review as determined by DOE/GO. For applicants who go forward to the comprehensive review, this notice will consist of the consensus strengths and weaknesses as determined by the Merit Review Committees.

## **4. Discussions and Award**

The Government may enter into discussions with a selected applicant for any reason deemed necessary, including but not limited to: (1) the budget is not appropriate or reasonable for the requirement; (2) only a portion of the application is selected for award; (3) the Government needs additional information to determine that the recipient is capable of complying with the requirements in 10 CFR Part 600; and/or (4) special terms and conditions are required. Failure to resolve satisfactorily the issues identified by the Government will preclude award to the applicant.

DOE reserves the right to conduct an independent third party review of financial capability for applicants that are selected for negotiation of award (including personal credit information of the principal(s) of a small business if there is insufficient information to determine financial capability of the organization).

## **C. ANTICIPATED NOTICE OF SELECTION AND AWARD DATES**

DOE plans to send invitations to submit final applications to successful preliminary applicants by **August 4, 2006**. **Note:** Only applicants who are favorably selected in the preliminary application phase will be eligible to submit final applications.

DOE anticipates notifying applicants selected for award and making awards early in Fiscal Year 2007.

## PART VI - AWARD ADMINISTRATION INFORMATION

### A. AWARD NOTICES

A Notice of Financial Assistance Award issued by the contracting officer is the authorizing award document. It normally includes, either as an attachment or by reference: 1. Special Terms and Conditions; 2. Applicable program regulations, if any; 3. Application as approved by DOE.; 4. DOE assistance regulations at 10 CFR part 600, or, for Federal Demonstration Partnership (FDP) institutions, the FDP terms and conditions; 5. National Policy Assurances To Be Incorporated As Award Terms; 6. Budget Summary; and 7. Federal Assistance Reporting Checklist, which identifies the reporting requirements.

### B. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS

#### 1. Administrative Requirements

The administrative requirements for DOE grants and cooperative agreements are contained in 10 CFR part 600 (See: <http://ecfr.gpoaccess.gov>), except for grants made to Federal Demonstration Partnership (FDP) institutions. The FDP terms and conditions and DOE FDP agency specific terms and conditions are located on the National Science Foundation web site at [http://www.nsf.gov/awards/managing/fed\\_dem\\_part.jsp](http://www.nsf.gov/awards/managing/fed_dem_part.jsp).

#### 2. Special Terms and Conditions and National Policy Requirements

##### **Special Terms and Conditions and National Policy Requirements**

The DOE Special Terms and Conditions for Use in Most Grants and Cooperative Agreements are located at <http://grants.pr.doe.gov>. The National Policy Assurances To Be Incorporated As Award Terms are located at <http://grants.pr.doe.gov>.

##### **Intellectual Property Provisions**

The standard DOE financial assistance intellectual property provisions applicable to the various types of recipients are located at [http://www.gc.doe.gov/techtrans/sipp\\_matrix.html](http://www.gc.doe.gov/techtrans/sipp_matrix.html).

##### **Statement of Substantial Involvement**

Category 1 awards will be cooperative agreements. These awards will include the following Statement of Substantial Involvement clause:

“The DOE Project Officer and HQ Program Technology Development Manager, in their project management oversight role for the Hydrogen Storage Centers of Excellence (Centers), will coordinate the awardees’ efforts along with the efforts of the other Center participants, in order to assure the optimal overall performance of the Center toward meeting DOE’s programmatic goals. In this role, the DOE Project Officer and HQ Program Technology Development Manager shall encourage collaboration among the awardee and the various Center participants.”

### C. REPORTING

Reporting requirements are identified on the Federal Assistance Reporting Checklist, DOE F 4600.2, attached to the award agreement. See <http://www.eere.energy.gov/golden/PDFs/4600-2.pdf> for the proposed Checklist for this program. Reporting requirements will include:

- Quarterly Technical Progress and Financial Status Reports
- Annual presentation at the DOE Hydrogen Program Merit Review and Peer Evaluation Meeting (typically in Washington, D.C.)
- Annual presentation at DOE/FreedomCAR and Fuel Partnership Hydrogen Storage Technical Team Meeting (typically in Detroit, MI)
- Annual submission to the DOE Hydrogen Program's Annual Progress Report
- Safety Plan

## **PART VII - QUESTIONS/AGENCY CONTACTS**

### **A. QUESTIONS**

Questions regarding the content of the announcement must be submitted through the “Submit Question” feature of the DOE Industry Interactive Procurement System (IIPS) at <http://e-center.doe.gov>. Locate the program announcement on IIPS and then click on the “Submit Question” button. Enter required information. You will receive an electronic notification that your question has been answered. DOE will respond to a question within 3 business days, unless a similar question and answer have already been posted on the website.

Questions relating to the registration process, system requirements, how an application form works, or the submittal process must be directed to Grants.gov at 1-800-518-4726 or [support@grants.gov](mailto:support@grants.gov). DOE cannot answer these questions.

### **B. AGENCY CONTACT**

Genevieve Wozniak  
H2storage@go.doe.gov  
Telephone: (303) 275-4942  
Fax: (303) 275-4754

## **PART VIII - OTHER INFORMATION**

### **A. MODIFICATIONS**

Notices of any modifications to this announcement will be posted on Grants.gov and the DOE Industry Interactive Procurement System (IIPS). You can receive an email when a modification or an announcement message is posted by joining the mailing list for this announcement through the link in IIPS. When you download the application at Grants.gov, you can also register to receive notifications of changes through Grants.gov.

### **B. GOVERNMENT RIGHT TO REJECT OR NEGOTIATE**

DOE reserves the right, without qualification, to reject any or all applications received in response to this announcement and to select any application, in whole or in part, as a basis for negotiation and/or award.

### **C. COMMITMENT OF PUBLIC FUNDS**

The Contracting Officer is the only individual who can make awards or commit the Government to the expenditure of public funds. A commitment by other than the Contracting Officer, either explicit or implied, is invalid.

### **D. PROPRIETARY APPLICATION INFORMATION**

Patentable ideas, trade secrets, proprietary or confidential commercial or financial information, disclosure of which may harm the applicant, should be included in an application only when such information is necessary to convey an understanding of the proposed project. The use and disclosure of such data may be restricted, provided the applicant includes the following legend on the first page of the project narrative and specifies the pages of the application which are to be restricted:

“The data contained in pages \_\_\_\_\_ of this application have been submitted in confidence and contain trade secrets or proprietary information, and such data shall be used or disclosed only for evaluation purposes, provided that if this applicant receives an award as a result of or in connection with the submission of this application, DOE shall have the right to use or disclose the data herein to the extent provided in the award. This restriction does not limit the government’s right to use or disclose data obtained without restriction from any source, including the applicant.”

To protect such data, each line or paragraph on the pages containing such data must be specifically identified and marked with a legend similar to the following:

“The following contains proprietary information that (name of applicant) requests not be released to persons outside the Government, except for purposes of review and evaluation.”

### **E. EVALUATION AND ADMINISTRATION BY NON-FEDERAL PERSONNEL**

In conducting the merit review evaluation, the Government may seek the advice of qualified non-Federal personnel as reviewers. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The applicant, by submitting its application, consents to the use of non-Federal reviewers/administrators. Non-Federal

reviewers must sign conflict of interest and non-disclosure agreements prior to reviewing an application. Non-Federal personnel conducting administrative activities must sign a non-disclosure agreement.

## **F. INTELLECTUAL PROPERTY DEVELOPED UNDER THIS PROGRAM**

Patent Rights. The government will have certain statutory rights in an invention that is conceived or first actually reduced to practice under a DOE award. 42 U.S.C. 5908 provides that title to such inventions vests in the United States, except where 35 U.S.C. 202 provides otherwise for nonprofit organizations or small business firms. However, the Secretary of Energy may waive all or any part of the rights of the United States subject to certain conditions. (See “Notice of Right to Request Patent Waiver” in paragraph G below.)

Rights in Technical Data. Normally, the government has unlimited rights in technical data created under a DOE agreement. Delivery or third party licensing of proprietary software or data developed solely at private expense will not normally be required except as specifically negotiated in a particular agreement to satisfy DOE’s own needs or to insure the commercialization of technology developed under a DOE agreement.

Special Protected Data Statutes. This program is covered by a special protected data statute (Refer to the Energy Policy Act of 2005, P.L. 109-58, Section 810. Disclosure). The provisions of the statute provide for the protection from public disclosure, for a period of up to five years for data first produced in the performance of an award. Generally, the provision entitled, Rights in Data – Programs Covered Under Special Protected Data Statutes, (10 CFR 600 Appendix A to Subpart D), would apply to an award made under this announcement. This provision will identify data or categories of data first produced in the performance of the award that will be made available to the public, notwithstanding the statutory authority to withhold data from public dissemination, and will also identify data that will be recognized by the parties as protected data.

## **G. NOTICE OF RIGHT TO REQUEST PATENT WAIVER**

Applicants may request a waiver of all or any part of the rights of the United States in inventions conceived or first actually reduced to practice in performance of an agreement as a result of this announcement, in advance of or within 30 days after the effective date of the award. Even if such advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver of the rights of the United States in identified inventions, i.e., individual inventions conceived or first actually reduced to practice in performance of the award. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784.

Domestic small businesses and domestic nonprofit organizations will receive the patent rights clause at 10 CFR 600.325, Appendix A, Patent Rights (Small Business Firms and Non-Profit Organizations), i.e., the implementation of the Bayh-Dole Act. This clause permits domestic small business and domestic nonprofit organizations to retain title to subject inventions. Therefore, small businesses and nonprofit organizations do not need to request a waiver.

For existing Category 1 projects, an advance class patent waiver is in place. New Category 1 applicants will be included under that advance class patent waiver as appropriate. For Category 2, each applicant must request a patent waiver individually during negotiations.

Large businesses selected for Category 1 must agree to the following licensing language, which will be included in their cooperative agreements:

*In the event that a participant, other than participants having the right to elect to retain title to inventions pursuant to 35 U.S.C. § 200 et seq., does not participate in subsequent phases of this project, the remaining participants of the Center of Excellence shall retain as a minimum a royalty-free, nonexclusive license throughout the world, with the right to grant sublicenses in each subject invention held by such participant pursuant to the class waiver, except as otherwise approved by Field Patent Counsel.*

#### **H. NOTICE REGARDING ELIGIBLE/INELIGIBLE ACTIVITIES**

Eligible activities under this program include those which describe and promote the understanding of scientific and technical aspects of specific energy technologies, but not those which encourage or support political activities such as the collection and dissemination of information related to potential, planned or pending legislation.

## APPENDIX A – DEFINITIONS

**“Amendment”** means a revision to a funding opportunity announcement.

**"Applicant"** means the legal entity or individual signing the Application. This entity or individual may be one organization or a single entity representing a group of organizations (such as a Consortium) that has chosen to submit a single Application in response to a funding opportunity announcement.

**"Application"** means the documentation submitted in response to a funding opportunity announcement. NOTE: Application is referred to as Proposal in IIPS.

**“Authorized Organization Representative (AOR)”** is the person with assigned privileges who is authorized to submit grant applications through Grants.gov on behalf of an organization. The privileges are assigned by the organization’s E-Business Point of Contact designated in the CCR.

**"Award"** means the written documentation executed by a DOE Contracting Officer, after an Applicant is selected, which contains the negotiated terms and conditions for providing Financial Assistance to the Applicant. A Financial Assistance Award may be either a Grant or a Cooperative Agreement.

**"Budget"** means the cost expenditure plan submitted in the Application, including both the DOE contribution and the Applicant Cost Share.

**"Consortium (plural consortia)"** means the group of organizations or individuals that have chosen to submit a single Application in response to a funding opportunity announcement.

**"Contracting Officer"** means the DOE official authorized to execute Awards on behalf of DOE and who is responsible for the business management and non-program aspects of the Financial Assistance process.

**"Cooperative Agreement"** means a Financial Assistance instrument used by DOE to transfer money or property when the principal purpose of the transaction is to accomplish a public purpose of support or stimulation authorized by Federal statute, and Substantial Involvement (see definition below) is anticipated between DOE and the Applicant during the performance of the contemplated activity.

**"Cost Sharing"** means the respective share of Total Project Costs to be contributed by the Applicant and by DOE. The percentage of Applicant Cost Share is to be applied to the Total Project Cost (i.e., the sum of Applicant plus DOE Cost Shares) rather than to the DOE contribution alone.

**“Central Contractor Registry (CCR)”** is the primary database which collects, validates, stores and disseminates data in support of agency missions. Funding Opportunity Announcements which require application submission through Grants.gov require that the organization first be registered in the CCR at <http://www.grants.gov/CCRRegister>.

**“Credential Provider”** is an organization that validates the electronic identity of an individual through electronic credentials, PINS, and passwords for Grants.gov. Funding Opportunity Announcements which require application submission through Grants.gov require that the



individual applying on behalf of an organization first be registered with the Credential Provider at <https://apply.grants.gov/OrcRegister>.

**“Data Universal Numbering System (DUNS) Number”** is a unique nine-character identification number issued by Dun and Bradstreet (D&B). Organizations must have a DUNS number prior to registering in the CCR. Call 1-866-705-5711 to receive one free of charge. <http://www.grants.gov/RequestaDUNS>

**“E-Business Point of Contact (POC)”** is the individual who is designated as the Electronic Business Point of Contact in the CCR registration. This person is the sole authority of the organization with the capability of designating or revoking an individual’s ability to submit grant applications on behalf of their organization through Grants.gov. <http://www.grants.gov/assets/EBIZRegCheck.doc>

**“E-Find”** is a Grants.gov webpage where you can search for Federal Funding Opportunities in FedGrants. <http://www.grants.gov/search/basic.do>

**“Financial Assistance”** means the transfer of money or property to an Applicant or Participant to accomplish a public purpose of support authorized by Federal statute through Grants or Cooperative Agreements and sub-awards. For DOE, it does not include direct loans, loan guarantees, price guarantees, purchase agreements, Cooperative Research and Development Agreements (CRADAs), or any other type of financial incentive instrument.

**“Federally Funded Research and Development Center (FFRDC)”** means a research laboratory as defined by Federal Acquisition Regulation 35.017.

**“Funding Opportunity Announcement (FOA)”** is a publicly available document by which a Federal agency makes known its intentions to award discretionary grants or cooperative agreements, usually as a result of competition for funds. Funding opportunity announcements may be known as program announcements, notices of funding availability, solicitations, or other names depending on the agency and type of program.

**“Grant”** means a Financial Assistance instrument used by DOE to transfer money or property when the principal purpose of the transaction is to accomplish a public purpose of support or stimulation authorized by Federal statute, and no Substantial Involvement is anticipated between DOE and the Applicant during the performance of the contemplated activity.

**“Grants.gov”** is the “storefront” web portal which allows organizations to electronically find and apply for competitive grant opportunities from all Federal grant-making agencies. Grants.gov is THE single access point for over 900 grant programs offered by the 26 Federal grant-making agencies. <http://www.grants.gov>

**“Industry Interactive Procurement System (IIPS)”** is DOE’s Internet-based procurement system which allows access to DOE’s business opportunities database, allows user registration and submittal of Applications: <http://e-center.doe.gov/>.

**“Key Personnel”** means the individuals who will have significant roles in planning and implementing the proposed Project on the part of the Applicant and Participants, including FFRDCs.

**“Marketing Partner Identification Number (MPIN)”** is a very important password designated by your organization when registering in CCR. The E-Business Point of Contact will need the MPIN to login to Grants.gov to assign privileges to the individual(s) authorized to submit applications on behalf of your organization. The MPIN must have 9 digits containing at least one alpha character (must be in capital letters) and one number (no spaces or special characters permitted).

**"Participant"** for purposes of this Announcement only, means any entity, except the Applicant substantially involved in a Consortium, or other business arrangement (including all parties to the Application at any tier), responding to the Announcement.

**"Project"** means the set of activities described in an Application, State plan, or other document that is approved by DOE for Financial Assistance (whether such Financial Assistance represents all or only a portion of the support necessary to carry out those activities).

**“Proposal”** is the term used in IIPS meaning the documentation submitted in response to an announcement. Also see Application.

**“Pure Edge Viewer”** is a small, free program which allows you to access, complete and submit applications electronically and securely through Grants.gov. You will not be able to access, complete, or submit an application through Grants.gov, unless the Pure Edge Viewer is downloaded on your computer. <http://www.grants.gov/DownloadViewer>.

**“Recipient”** means the organization, individual, or other entity that receives a Financial Assistance Award from DOE, is financially accountable for the use of any DOE funds or property provided for the performance of the Project, and is legally responsible for carrying out the terms and condition of the award.

**"Selection"** means the determination by the DOE Selection Official that negotiations take place for certain Projects with the intent of awarding a Financial Assistance instrument.

**"Selection Official"** means the DOE official designated to select Applications for negotiation toward Award under a subject announcement.

**"Substantial Involvement"** means involvement on the part of the Government. DOE's involvement may include shared responsibility for the performance of the Project; providing technical assistance or guidance which the Applicant is to follow; and the right to intervene in the conduct or performance of the Project. Such involvement will be negotiated with each Applicant prior to signing any agreement.

**"Total Project Cost"** means all the funds to complete the effort proposed by the Applicant, including DOE funds (including direct funding of any FFRDC) plus all other funds that will be committed by the Applicant as Cost Sharing.

## APPENDIX B – GRANTS.GOV

In addition to the links provided in the Announcement, we are providing Appendix B to assist you in the registration process.

### **“Very Important”**

**Please read through the information below prior to starting the registration process. This information will assist you in making the registration process as seamless as possible. It is important to follow the steps in the order outlined below, allowing the time specified between each of the steps. We strongly encourage each applicant to confirm all registrations (e.g., DUNS No., CCR, Credential Provider, and Grants.gov) at least 30 days prior to the announcement closing date.**

- 1) Request a DUNS Number** - Follow the instructions at <http://www.grants.gov/RequestaDUNS>. It is highly recommended that the DUNS number be requested by telephone at 1-866-705-5711, which will take about 10 minutes. There is no charge. ***Once the telephone registration is completed, you must allow 24 hours before attempting to use the DUNS number in the next step of registering with the Central Contractor Registry (CCR).***
- 2) Register with the Central Contractor Registry (CCR)** - Go to <http://www.grants.gov/CCRRegister> and click on the “Help” button to locate the tutorial. Print the tutorial for reference and follow the instructions in the link above. We also recommend that you print and complete the 7-page CCR Worksheet at <http://www.ccr.gov/CCRRegTemplate.pdf> prior to registration, as it may take up to 3 days to gather the information needed for the worksheet. You are required to designate an Electronic Business Point of Contact (E-Business POC) and a Marketing Partner Identification Number (MPIN) in the CCR. It is important to provide the MPIN to the E-Business POC. For assistance with the CCR, contact the Assistance Center at 1-888-227-2423 or at [CCR@dlis.dla.mil](mailto:CCR@dlis.dla.mil). You may also access the CCR Handbook at <http://www.ccr.gov/handbook.asp>.
- 3) Register with the Credential Provider** - AORs must register with the Credential Provider. ***AORs must wait a minimum of 3 business days for the CCR to become active before attempting to register with the credential provider.*** Go to <https://apply.grants.gov/OrcRegister> and click on the “Help” button to locate the tutorial. Print the tutorial for reference and follow the instructions in the link above. Record the user ID and password that you enter because you will need this information to register with Grants.gov as an AOR. ***AORs must wait approximately 20 minutes after completing the Credential Provider registration before going to the next step of registering with Grants.gov.*** If you encounter any problems, the Credential Provider may be reached at 800-386-6820 or via email at [eauthhelp@orc.com](mailto:eauthhelp@orc.com) or [pkihelp@orc.com](mailto:pkihelp@orc.com).
- 4) Register with Grants.gov** - AORs must register with Grants.gov, utilizing the User ID and password obtained from registering with the Credential Provider. Go to <https://apply.grants.gov/GrantsgovRegister#> and click on the “Help” button to locate the tutorial. Print the tutorial for reference and follow the instructions in the link above. After you have completed the Grants.gov registration process, you will receive a confirmation that indicates

whether your registration was successful.

After AORs successfully register with Grants.gov, an email will be generated to the E-Business Point of Contact (POC) that was designated in the CCR, informing them that an individual from their organization has registered in Grants.gov to be an AOR, capable of submitting applications in Grants.gov on behalf of their organization. (Further Information regarding the Electronic Business POC is provided below.) AORs will not be able to submit an application until they receive authorization from the E-Business POC. ***If the AOR does not receive an email authorization from the E-Business POC within 1 business day, contact the E-Business POC.*** If you encounter any problems, contact Customer Support at 1-800-518-4726 or [support@grants.gov](mailto:support@grants.gov). For tracking purposes, Customer Support will assign you a case number that should be provided to them each time you call.

**Designate Privileges to the AOR** - The Electronic Business POC is the sole authority of the organization with the capability of designating, or revoking, an individual's ability to submit grant applications on behalf of their organization through Grants.gov. Once the E-Business POC receives the email notification from the individual wishing to be recognized as an AOR, the E-Business POC should go to <https://apply.grants.gov/AorMgrGetID>, click on the "Help" button to locate the tutorial, print the tutorial for reference, then log on utilizing the DUNS Number and the Marketing Partner Identification Number (MPIN) that was designated by their organization when registering in the CCR and follow the instructions for designating privileges to the AOR. If you cannot locate the MPIN, contact the CCR Assistance Center at 1-888-227-2423 or at [CCR@dlis.dla.mil](mailto:CCR@dlis.dla.mil).

**5) Install the PureEdge Viewer – *Authorized Organization Representatives (AORs) are the individuals that will be given the authority to submit applications on behalf of their organization.*** All AORs must download and install the PureEdge Viewer on their computer by following the instructions at <http://www.grants.gov/DownloadViewer>. This small, free program will allow AORs to access, complete, and submit applications electronically and securely. If you encounter any problems, contact customer Support at 1-800-518-4726 or [support@grants.gov](mailto:support@grants.gov). (This step may be done earlier in the process).

**6) Submit Application in Grants.gov** - Once the E-Business POC has authorized privileges to the AOR, the AOR will receive an email notification that they have been given authorization. The AOR may then proceed to submit an application in Grants.gov (see the "Install the PureEdge Viewer" step above). For application instructions, go to <http://www.grants.gov/Apply>. The training demonstration at <http://www.grants.gov/CompleteApplication> will assist AORs in the application process. Remember that you must open and complete the Application for Federal Assistance (SF-424) first, as this form will automatically populate data fields in other forms. If you encounter any problems, contact customer Support at 1-800-518-4726 or at [support@grants.gov](mailto:support@grants.gov). If you forget your user name or password, follow the instructions provided in the Credential Provider tutorial.

**NOTE: Tutorials may be printed by right-clicking on the tutorial and selecting "print".** In addition to the tutorials, the User Guide is a valuable resource. The User Guide is found at [http://www.grants.gov/GrantsGov\\_UST\\_Grantee/SSL/WebHelp/userguide.doc](http://www.grants.gov/GrantsGov_UST_Grantee/SSL/WebHelp/userguide.doc)

## APPENDIX C – TECHNOLOGY TOPICS

### TECHNICAL CHALLENGES

For transportation, the overarching technical challenge for hydrogen storage is how to store the amount of hydrogen required for a conventional driving range (greater than 300 miles), within the vehicular constraints of weight, volume, efficiency, safety, and cost. Durability over the performance lifetime of these systems, as well as acceptable refueling times and hydrogen delivery flow rates must be achieved. The key technical challenges for all approaches of vehicular storage include:

- **System Volume and Weight.** The volume and weight of hydrogen storage systems are presently too high, resulting in inadequate vehicle range compared to conventional petroleum fueled vehicles. Storage media, materials of construction and components are needed that allow compact, lightweight hydrogen storage systems while enabling greater than 300-mile range in all light-duty vehicle platforms. Reducing weight and volume of thermal management components is also required.
- **System Cost.** The cost of on-board hydrogen storage systems is too high, particularly in comparison with conventional storage systems for petroleum fuels. Low-cost storage media, materials of construction and components for hydrogen storage systems are needed, as well as low-cost, high-volume manufacturing methods.
- **Efficiency.** Energy efficiency is a challenge for all hydrogen storage approaches. The energy required to get hydrogen in and out is an issue for on-board reversible materials. Life-cycle energy efficiency is a challenge for chemical hydrogen storage in which the by-product is regenerated off board the vehicle. Thermal management for charging and releasing hydrogen from the storage system needs to be optimized to increase overall efficiency for all approaches.
- **Durability/ Operability.** Durability of hydrogen storage systems is inadequate. Storage media, materials of construction and balance-of-plant components are needed that allow hydrogen storage systems with a lifetime of at least 1500 cycles and with tolerance to hydrogen fuel contaminants. An additional durability issue for material-based approaches is the delivery of sufficient quality hydrogen for the vehicle power plant.
- **Charging/ Discharging Rates.** In general and especially for material-based approaches, hydrogen refueling times are too long. There is a need to develop hydrogen storage systems with refueling times of less than three minutes for a 5-kg of hydrogen charge, over the lifetime of the system. Thermal management that enables quicker refueling is a critical issue that must be addressed. Also, all storage system approaches must be able to supply sufficient flow rate of hydrogen to the vehicle power plant (e.g. fuel cell or internal combustion engine) to meet the required power demand.
- **Thermal Management.** Approaches are needed to address heat input and removal requirements both during hydrogen charging and discharging for all technologies. In general, the main technical challenge is heat removal upon re-filling of hydrogen for on-board reversible materials within fueling time requirements. On-board reversible materials typically require heat to release hydrogen on board the vehicle. Heat must be provided to the storage media at reasonable temperatures to meet the flow rates needed by the vehicle power plant, preferably using the waste heat of the power plant. Depending upon the chemistry, chemical hydrogen approaches often are exothermic upon release of hydrogen to the power plant, or optimally thermal neutral. By virtue of

the chemistry used, chemical hydrogen approaches require significant energy to regenerate the spent material and by-products prior to re-use; this done off the vehicle.

- **Codes & Standards.** Applicable codes and standards for hydrogen storage systems and interface technologies, which will facilitate implementation/commercialization and assure safety and public acceptance, have not been established. Standardized hardware and operating procedures, and applicable codes and standards, are required.
- **Life-Cycle and Efficiency Analyses.** Systematic analyses for the full life-cycle cost, efficiency, and environmental impact for hydrogen storage systems are required.

Additional issues specific to reversible material-based hydrogen storage systems (i.e. materials that may be charged and discharged reversibly on board a vehicle) are:

- **Lack of Understanding of Hydrogen Physisorption and Chemisorption.** Fundamental understanding of hydrogen physisorption and chemisorption processes is lacking. Improved understanding and optimization of adsorption/absorption and desorption kinetics are needed to optimize hydrogen uptake and release capacity rates. An understanding of chemical reactivity and material properties, particularly with respect to exposure under different conditions (air, moisture, etc.) is also lacking.
- **Reproducibility of Performance.** Standard test protocols for evaluation of hydrogen storage materials are lacking. Reproducibility of performance both in synthesis of the material/media and measurement of key hydrogen storage performance metrics is an issue. Standard test protocols related to performance over time such as accelerated aging tests as well as protocols evaluating materials safety properties and reactivity over time are also lacking.

Additional issues specific to chemical hydrogen storage systems (i.e. materials that may discharge hydrogen on board but need to be regenerated off board) are:

- **Regeneration Processes.** Low-cost, energy efficient regeneration processes have not been established. Full life-cycle analyses need to be performed to understand cost, efficiency and environmental impacts.
- **By-Product/Spent Material Removal.** The refueling process is potentially complicated by removal of the by-product and/or spent material. System designs must be developed to address this issue and the infrastructure requirements for off-board regeneration.

The current status of various approaches are monitored continuously by DOE and compared to DOE system targets. Any proposed approaches should show potential to meet or exceed DOE's 2010 targets with potential to meet the 2015 targets.

## GOALS AND TECHNICAL TARGETS

The goal of the DOE hydrogen storage activity is to fund the research and development of viable hydrogen storage technologies primarily for on-board vehicular applications. The major objectives for on-board vehicular hydrogen storage are:

- By 2010, develop and verify on-board hydrogen storage systems achieving 2 kWh/kg (6 wt.%), 1.5 kWh/Liter, and \$4/kWh.



- By 2015, develop and verify on-board hydrogen storage systems achieving 3 kWh/kg (9 wt.%), 2.7 kWh/Liter, and \$2/kWh.

Table 1 shows the technical targets for on-board hydrogen storage systems<sup>3</sup>. The technical targets for on-board hydrogen storage systems were established through the FreedomCAR partnership between DOE and the U.S. Council of Automotive Research (USCAR). The partnership was recently expanded to include the major energy companies and renamed the FreedomCAR and Fuel Partnership<sup>4</sup>.

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<sup>3</sup> See the following websites for more details on the targets:  
[http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/freedomcar\\_targets\\_explanations.pdf](http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/freedomcar_targets_explanations.pdf) and  
<http://www.eere.energy.gov/hydrogenandfuelcells/mypp>.

<sup>4</sup> The FreedomCAR and Fuel Partnership includes U.S. Department of Energy, USCAR (DaimlerChrysler Corporation, Ford Motor Company and General Motors Corporation), BP America, ChevronTexaco, ConocoPhillips, ExxonMobil Corporation and Shell Hydrogen U.S.

Table 1 Technical Targets: On-Board Hydrogen Storage Systems <sup>a,b,c</sup>

Storage Parameter	Units	2007	2010	2015
System Gravimetric Capacity: <b>Usable, specific-energy from H<sub>2</sub> (net useful energy/max system mass)<sup>d</sup></b>	<b>kWh/kg (kg H<sub>2</sub>/kg system)</b>	<b>1.5 (0.045)</b>	<b>2 (0.06)</b>	<b>3 (0.09)</b>
System Volumetric Capacity: <b>Usable energy density from H<sub>2</sub> (net useful energy/max system volume)</b>	<b>kWh/L (kg H<sub>2</sub>/L system)</b>	<b>1.2 (0.036)</b>	<b>1.5 (0.045)</b>	<b>2.7 (0.081)</b>
Storage system cost <sup>e</sup> (& fuel cost) <sup>f</sup>	<b>\$/kWh net (\$/kg H<sub>2</sub>) \$/gge at pump</b>	<b>6 (200) ---</b>	<b>4 (133) 2-3</b>	<b>2 (67) 2-3</b>
Durability/Operability <ul style="list-style-type: none"> <li>Operating ambient temperature <sup>g</sup></li> <li>Min/max delivery temperature</li> <li>Cycle life variation <sup>h</sup></li> <li>Cycle life (1/4 tank to full) <sup>i</sup></li> <li>Min delivery pressure from tank; FC= fuel cell, I=ICE</li> <li>Max delivery pressure <sup>j</sup></li> </ul>	<sup>°C</sup> <sup>°C</sup> % of mean (min) at %confidence Cycles Atm (abs) Atm (abs)	-20/50 (sun) -30/85 N/A 500 8FC / 10ICE 100	-30/50 (sun) -40/85 90/90 1000 4FC / 35ICE 100	-40/60 (sun) -40/85 99/90 1500 3FC / 35ICE 100
Charging/discharging Rates <ul style="list-style-type: none"> <li>System fill time (for 5 kg)</li> <li>Minimum full flow rate</li> <li>Start time to full flow (20 °C) <sup>k</sup></li> <li>Start time to full flow (- 20 °C) <sup>k</sup></li> <li>Transient response 10%-90% and 90% - 0%<sup>l</sup></li> </ul>	min (g/s)/kW s s S	10 0.02 15 30 1.75	3 0.02 5 15 0.75	2.5 0.02 5 15 0.75
Fuel Purity (H <sub>2</sub> from storage) <sup>m</sup>	<b>% H<sub>2</sub></b>	<b>99.99 (dry basis)</b>		
Environmental Health & Safety <ul style="list-style-type: none"> <li>Permeation &amp; leakage <sup>n</sup></li> <li>Toxicity</li> <li>Safety</li> <li>Loss of useable H<sub>2</sub> <sup>o</sup></li> </ul>	Scc/h - (g/h)/kg H <sub>2</sub> stored	<b>Meets or exceeds applicable standards</b>		
		1	0.1	0.05

Footnotes to Table 1:

- <sup>a.</sup> Based on the lower heating value of hydrogen and greater than 300-mile vehicle range; targets are for complete system, including tank, material, valves, regulators, piping, mounting brackets, insulation, added cooling capacity, and/or other balance-of-plant components.



- b. Unless otherwise indicated, all targets are for both internal combustion engine and for fuel cell use, based on the low likelihood of power-plant specific fuel being commercially viable.
- c. Systems must be energy efficient. For reversible systems, greater than 90% energy efficiency for the energy delivered to the power plant from the on-board storage system is required. For systems regenerated off-board, the energy content of the hydrogen delivered to the automotive power plant should be greater than 60% of the total energy input to the process, including the input energy of hydrogen and any other fuel streams for generating process heat and electrical energy. This is based on the DOE on-board target of 90% efficiency and the DOE off-board energy efficiency targets of 79% for hydrogen produced from natural gas and 85% for well-to-tank efficiency.
- d. Generally the 'full' mass (including hydrogen) is used, for systems that gain weight, the highest mass during discharge is used.
- e. 2003 US\$; total cost includes any component replacement if needed over 15 years or 150,000 mile life.
- f. 2001 US\$; includes off-board costs such as liquefaction, compression, regeneration, etc; 2015 target.
- g. Stated ambient temperature plus full solar load No allowable performance degradation from -20C to 40C. Allowable degradation outside these limits is TBD.
- h. All targets must be achieved at end of life.
- i. Equivalent to 100,000; 200,000; and 300,000 miles respectively (current gasoline tank spec).
- j. In the near term, the forecourt should be capable of delivering 10,000 psi compressed hydrogen, liquid hydrogen, or chilled hydrogen (77 K) at 5000 psi. In the long term, it is anticipated that delivery pressures will be reduced to between 50 and 150 atm for solid state storage systems, based on today's knowledge of sodium alanates.
- k. Flow must initiate within 25% of target time.
- l. At operating temperature.
- m. For fuel cell systems, meets ISO/PDTS 14687-2. Total non-particulates, 100 ppm; H<sub>2</sub>O, 5 ppm; total hydrocarbons (C<sub>1</sub> basis), 2 ppm; O<sub>2</sub>, 5 ppm; He, N<sub>2</sub>, Ar combined, 100 ppm; CO<sub>2</sub>, 10 ppm; CO, 0.2 ppm; total S, 0.004 ppm; HCHO, 0.01 ppm; HCOOH, 0.2 ppm; NH<sub>3</sub>, 0.1 ppm; total halogenates, 0.05 ppm; maximum particle size, <10 µm, particulate concentration, <10µg/L H<sub>2</sub>. The storage system will not provide any purification, but will receive incoming hydrogen at the purity levels required for the fuel cell. Some storage technologies may produce contaminants for which effects are unknown; these will be addressed as more information becomes available.
- n. Total hydrogen lost into the environment as H<sub>2</sub>; relates to hydrogen accumulation in enclosed spaces. Storage system must comply with CSA/NGV2 standards for vehicular tanks. This includes any coating or enclosure that incorporates the envelope of the storage system.
- o. Total hydrogen lost from the storage system, including leaked or vented hydrogen; relates to loss of range.

## THE NATIONAL HYDROGEN STORAGE PROJECT

The Department of Energy has conducted a series of workshops to identify R&D needs and to assess priorities and strategies for on-board hydrogen storage. These include a Hydrogen Storage Materials Workshop held in August 2002, a Hydrogen Storage “Think Tank” Meeting held in March 2003, and a Basic Energy Sciences Workshop held in May 2003. The proceedings of these workshops are available on DOE websites at [http://www.eere.energy.gov/hydrogenandfuelcells/wkshp\\_h2\\_storage.html](http://www.eere.energy.gov/hydrogenandfuelcells/wkshp_h2_storage.html); [http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/h2\\_storage\\_think\\_tank.pdf](http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/h2_storage_think_tank.pdf); and [http://www.sc.doe.gov/bes/reports/files/NHE\\_rpt.pdf](http://www.sc.doe.gov/bes/reports/files/NHE_rpt.pdf).

Based on the findings from these workshops, the DOE issued a “Grand Challenge” to the global scientific community for research in hydrogen storage in July 2003. This Grand Challenge called for the establishment of hydrogen storage Centers of Excellence in Metal Hydrides, Chemical Hydrogen Storage, and Carbon-Based Materials, with multiple university, industry, and federal laboratory partners. In addition, independent projects were solicited on new materials and concepts, off-board hydrogen storage systems, and analyses of life cycle cost, performance and environmental impact. Complementing the Grand Challenge, the DOE Office of Science issued a solicitation in 2004 for basic research to help overcome key hurdles in hydrogen production, storage, and conversion.

The DOE Centers of Excellence and independent projects, together with existing DOE hydrogen storage efforts, constitute the framework of the National Hydrogen Storage Project. The Metal Hydride Center includes Sandia National Laboratory in Livermore, California and multiple university, industry and federal laboratory partners. The Metal Hydride Center focuses on the development of advanced metal hydride materials including light-weight advanced complex hydrides, destabilized binary hydrides, intermetallic hydrides, modified lithium amides, and other on-board reversible hydrides. The Chemical Hydrogen Storage Center includes the Los Alamos National Laboratory in Los Alamos, New Mexico, the Pacific Northwest National Laboratory in Richland, Washington, and multiple university and industry partners. The Chemical Hydrogen Center focuses on three “tiers” of R&D for chemical hydrogen storage: borohydride-water systems, novel boron chemistry, and innovation beyond boron. The Carbon-Based Materials Center includes the National Renewable Energy Laboratory in Golden, Colorado and multiple university, industry and federal laboratory partners. The Carbon-Based Materials Center focuses on breakthrough concepts for storing hydrogen in high surface area adsorbents such as hybrid carbon nanotubes, aerogels, and nanofibers, as well as metal-organic frameworks and conducting polymers. The National Hydrogen Storage Project also involves independent projects on new hydrogen storage materials and concepts, material and system testing, and system analyses.

## SCOPE OF ANNOUNCEMENT

DOE is soliciting applications for the research and development of innovative technologies for on-board vehicular hydrogen storage. Further information on the hydrogen program can be obtained from the Multi-Year Program Plan at <http://www.eere.energy.gov/hydrogenandfuelcells/mypp>, and from the DOE Hydrogen Program’s Annual Progress Reports at [http://www.hydrogen.energy.gov/annual\\_progress05.html](http://www.hydrogen.energy.gov/annual_progress05.html) and

[http://www.hydrogen.energy.gov/annual\\_progress04.html](http://www.hydrogen.energy.gov/annual_progress04.html).

It is intended that this announcement will be issued on an annual basis, subject to congressional appropriations and direction. New projects will be selected each fiscal year based on technical merit review, program policy review and the availability of funds. Projects will typically be of two to five-year duration, with overall go/no-go decision points between the phases. The project schedule should take into consideration the meeting of key milestones in the Multi-Year Program Plan mentioned above.

The application process will include two phases -- a preliminary application phase and a final application phase. Only applicants who are favorably selected in the preliminary application phase will be eligible to submit final applications.

The technical topics listed below under Categories 1 and 2 are the only eligible research areas under this announcement.

Applicants seeking to become a partner in a Center of Excellence should apply to Category 1. The appropriate Center should be clearly stated on the cover page of the application. If the work is applicable to more than one of the Centers, then each of the applicable Centers should be stated on the cover page.

Applicants not seeking to become a partner in a Center of Excellence should apply only to Category 2. The appropriate technical topic should be clearly stated on the cover page of the application.

Applicants may apply for both Category 1 and Category 2 with the same application, provided that the application meets the technical topic requirements for both categories as described below. However, applicants should not submit separate applications for the same project under both categories. Duplicate applications will not be reviewed separately. Applicants wishing to apply to both categories with the same application must state both the appropriate Category 1 Center of Excellence and the appropriate Category 2 technical topic on the cover page of their application. Category 1 applications will not be considered for award under Category 2 unless the application clearly states the applicant's intention to apply for both categories with the same application.

For either category (or both), applicants may not submit an application that covers more than one technical topic, (i.e., separate applications must be submitted for separate technical topics).

Applications for Category 1 and for Category 2 (and for both) will be evaluated using the same criteria, regardless of category designation. The potential for an applicant to become a member in a Center of Excellence will be considered by DOE only after selections are made and will have no effect on the evaluation and selection process. The technical evaluation criteria and program policy factors are identical for both categories.

### Category 1:

Category 1 proposals are intended to maintain the vitality and flexibility of the Centers of Excellence by establishing new technical approaches and/or new experimental or theoretical capabilities that are compatible with the overall Center objectives.

Projects are sought that are supportive of and complementary to the activities of any of the existing Hydrogen Storage Centers of Excellence in Metal Hydrides, Chemical Hydrogen Storage, and Carbon-Based Materials. Such projects must help establish important new technical approaches or capabilities not presently available at the Centers. A successful applicant may become a Center partner, provided that the applicant signs an existing non-disclosure agreement that has been signed by each of the existing Center partners. The appropriate Center of Excellence must be clearly stated on the cover page of the application. If the work is applicable to more than one Center, then each applicable Center should be stated on the cover page.

The existing partners' work within each of the Centers of Excellence can be found in the DOE Hydrogen Program's Annual Progress Reports at [http://www.hydrogen.energy.gov/annual\\_progress05.html](http://www.hydrogen.energy.gov/annual_progress05.html) and [http://www.hydrogen.energy.gov/annual\\_progress04.html](http://www.hydrogen.energy.gov/annual_progress04.html). The National Hydrogen Storage Project background can be found at [http://www.eere.energy.gov/hydrogenandfuelcells/storage/national\\_proj.html](http://www.eere.energy.gov/hydrogenandfuelcells/storage/national_proj.html).

Category 1 applicants are encouraged to research the ongoing Center work at the various websites referenced in this announcement. The current Center objectives are given below.

#### **DOE Metal Hydride Center of Excellence:**

The DOE Metal Hydride Center focuses on the development of advanced metal hydride materials, including lightweight, high-capacity complex hydrides; destabilized binary hydrides; intermetallic hydrides; modified lithium amides; and other onboard reversible hydrides. The Metal Hydride Center has two main objectives: (1) develop improved lightweight, high-capacity hydride-based materials for vehicular applications, and (2) pursue systems engineering science for the ultimate integration and demonstration of these advanced materials into a complete hydrogen storage and delivery system.

The DOE Metal Hydride Center proposes to develop an advanced hydrogen storage system based on parallel research in four classes of hydride-based materials. These include 1) advanced complex hydrides of the light elements Li, Na, Mg, Ti, Ca, B, Al, Si; 2) destabilized binary hydrides (e.g. Li-Si destabilized H<sub>2</sub> release from LiH); 3) novel intermetallic hydrides (e.g. Mg-M-H alloys); and 4) other on-board reversible hydride materials, such as lithium amides, that demonstrate promising hydrogen storage properties.

The Center will ultimately select and demonstrate a prototype hydrogen storage system that has the potential to meet DOE's hydrogen storage performance goals.

#### **DOE Chemical Hydrogen Storage Center of Excellence:**

The DOE Chemical Hydrogen Storage Center of Excellence focuses on developing advanced chemical hydrogen storage materials and studying their associated engineering requirements

for on-board vehicular applications. The goal of the center is to develop an advanced hydrogen storage system by pursuing three “tiers” of R&D for chemical hydrogen storage that most likely will require off-board regeneration.

Tier 1, Borohydride/Water, concentrates on the chemistry required for facile reaction of borohydride,  $\text{BH}_4^-$ , compounds such as  $\text{NaBH}_4$  with water to release hydrogen, and for lowering the cost of converting the resulting borates back to  $\text{BH}_4^-$ . The overall goal of Tier 1 is to develop new chemistry and study its engineering requirements to remove barriers to implementation of  $\text{NaBH}_4$  technology for hydrogen storage.

Tier 2, Novel Boron Chemistry, addresses the possibility that the expense of converting B-O bonded species back to  $\text{BH}_4^-$  could remain unacceptably high, and focuses on chemical processes that release hydrogen from other B-H bonded species that may be less energy-intensive and less expensive to regenerate than borohydride. The overall goal of Tier 2 is to design and develop new boron-hydride chemistry and study its engineering requirements with improved thermodynamics for regeneration of spent material after hydrogen release.

Tier 3, Innovation beyond Boron, examines materials comprising light elements other than boron that could satisfy non-toxicity and mass/volume-storage requirements for serving as useful sources of hydrogen, while at the same time requiring minimal energy cost of recycling/regenerating. The overall goal of Tier 3 is to identify and develop new compounds and materials and study their engineering requirements for chemical hydrogen storage.

The Center will ultimately select and demonstrate a prototype hydrogen storage system that has the potential to meet DOE’s hydrogen storage performance goals.

#### **DOE Carbon-Based Materials Center of Excellence:**

The DOE Center of Excellence on Carbon-Based Materials focuses on developing high surface area adsorbents and carbon-based materials for vehicular hydrogen storage systems that are reversible on board. Through parallel efforts, the Center proposes to determine the limits of performance for specific material systems and extract general mechanistic information that can be used for further design and optimization. A key effort is to determine the relationship between nanoscale structure and the energetics of hydrogen binding using a variety of experimental and theoretical tools and well-defined nanostructured materials. Materials of interest include single-walled carbon nanotubes, graphite nanofibers, multi-walled nanotubes, alkali metal intercalated carbons and nanotubes, carbon nanohorns, chemomechanically processed (ball-milled) materials, metal catalyst decorated and substitutionally doped versions of these, conducting polymers, and metal-organic frameworks.

The Center will ultimately select and demonstrate a prototype hydrogen storage system that has the potential to meet DOE’s hydrogen storage performance goals.

#### **Objectives for Category 1:**

Category 1 projects will be funded for a 2 to 5 year period consisting of two phases with a project go/no-go decision point at the end of the first phase.

Phase 1 is intended to explore new concepts, to develop novel materials, and to investigate material properties and hydrogen storage performance. The primary Phase 1 objectives are to

assess the feasibility of new hydrogen storage materials and concepts and to determine their potential to meet the 2010 performance targets. Concepts and materials with potential to meet the 2015 performance targets may also be explored. Results should be reproducible, and technical data reported to DOE should include, but are not limited to, data on capacity, kinetics, and thermodynamics.

Phase 2 is intended to address further material development and to improve, optimize, and demonstrate material performance and properties. The primary Phase 2 objectives are to demonstrate that the material or concept meets the 2010 performance targets, and to show potential toward meeting the 2015 performance targets. Results should be reproducible, and technical data reported to DOE should include, but are not limited to, data on capacity, kinetics, thermodynamics, cycle life, and other material properties. An additional objective for Phase 2 is to provide input to DOE relevant to the design and construction of a system prototype.

Material samples resulting from the R&D effort will be submitted for independent, standardized testing at a facility to be specified by DOE.

#### **Cost share requirements for Category 1:**

Applicants must contribute a minimum of 20% cost share (of the total project cost).

#### **Category 2:**

Category 2 projects are independent projects (i.e. not associated with a DOE Center) that propose a new hydrogen storage material and/or concept and seek to establish the feasibility of the proposed new approach, **in one of three technical topic areas summarized below**. Such projects will typically be high risk, “outside the box” concepts but with technical credibility and potential for high pay-off. Also solicited are novel reactor design/engineering concepts, novel approaches to thermal management in hydrogen storage systems, methods for combinatorial or high throughput screening for rapidly identifying high storage capacity materials, and systems, storage material safety, and environmental analyses.

Applications are sought for independent research and development projects addressing one of the following three technical topics. The appropriate **category and** topic must be clearly stated on the cover page of the application. Applicants may not submit an application that covers more than one topic, i.e. separate applications must be submitted for separate topics. Research and development of cylindrical high pressure or liquid on-board storage tanks and off-board storage are not sought under this announcement and will not be reviewed.

#### **Topic 1: Materials Discovery**

Research and development areas sought under Topic 1 include, but are not limited to, new materials and concepts in the following areas: advanced metal hydrides, chemical hydrogen storage materials, carbon-based materials, high surface area adsorbents, and completely novel approaches. For chemical hydrogen storage materials, off-board regeneration must be considered. Improvements to the hydrogen storage gravimetric and volumetric capacity of new materials as well as hydrogen uptake and discharge kinetics, energy efficiency, operating temperature and pressure, cycle life, cost and durability of materials upon exposure to contaminants are appropriate. Novel materials or chemistry for off-board regeneration of chemical hydrogen storage carriers are solicited. Development and application of new



processes (such as mechanochemistry, sonochemistry, irradiation, etc.) that can aid in the development of unique material properties (nanostructures, low cost manufacturing, etc.) are also applicable under this topic. Topic 1 would also include approaches for high throughput/combinatorial synthesis, screening and testing of storage materials and other novel characterization techniques that can aid in and be applied to the discovery of new materials.

**Objectives for Topic 1**

Topic 1 projects will be funded for a 2 to 5 year period consisting of two phases with a project go/no-go decision point at the end of the first phase.

Phase 1 is intended to explore new concepts, to develop novel materials, and to investigate material properties and hydrogen storage performance. The primary Phase 1 objectives are to assess the feasibility of new hydrogen storage materials and concepts and to determine their potential to meet the 2010 performance targets. Concepts and materials that show potential to meet the 2015 performance targets may also be explored. Results should be reproducible, and technical data reported to DOE should include, but are not limited to, data on capacity, kinetics, and thermodynamics.

Phase 2 is intended to address further material development and to improve, optimize, and demonstrate material performance and properties. The primary Phase 2 objectives are to demonstrate that the material or concept meets the 2010 performance targets and to show potential toward meeting the 2015 performance targets. Results should be reproducible, and technical data reported to DOE should include, but are not limited to, data on capacity, kinetics, thermodynamics, cycle life, and other material properties. An additional objective for Phase 2 is to provide input to DOE relevant to the design and construction of a system prototype.

Material samples resulting from the R&D effort will be submitted for independent, standardized testing at a facility to be specified by DOE.

**Cost share requirements for Topic 1:**

Applicants must contribute a minimum of 20% cost share (of the total project cost).

**Topic 2: Engineering Science**

Research and development areas sought under Topic 2 include, but are not limited to, novel reactor design, engineering concepts, and viable approaches to thermal management. Rather than standard reactor design engineering, this topic is for completely new concepts that have the potential to significantly reduce the weight and volume of storage systems while meeting all safety, cost and performance requirements, including thermal management during hydrogen refueling and release. Novel reactor design, engineering concepts and processes for off-board regeneration of chemical hydrogen storage materials are applicable under this topic. Applicable hydrogen storage materials include, but are not limited to, metal hydrides, chemical hydrogen storage materials, carbon-based materials, high surface area adsorbents, and hybrid materials. While the focus is on materials-based technologies that operate at low pressure (less than ~ 150 atm), novel approaches to low cost conformable containers for moderate to high pressure systems (e.g. up to 700 atm) would also be applicable.

In addition, proposals related to the testing and characterization of material safety properties would be applicable under Topic 2. Development of an understanding of environmental and chemical reactivity of materials and the stability of materials upon exposure to various conditions and contaminants is also applicable. Development and application of standard testing techniques to quantitatively evaluate both materials and systems in terms of safety / environmental impact characteristics and exposure to a variety of operating and handling conditions (such as exposure to air, humidity, etc.) are also applicable under Topic 2.

**Objectives for Topic 2:**

Topic 2 projects will be funded for a 2 to 5 year period consisting of two phases with a project go/no-go decision point at the end of the first phase.

Phase 1 is intended to investigate novel engineering concepts for hydrogen storage systems and to develop a greater understanding of engineering science related issues and/or material safety/environmental impact properties. The Phase 1 objective is to assess the feasibility of novel engineering concepts to determine their potential to enable hydrogen storage systems to meet the 2010 performance targets. Concepts that show potential to enable meeting the 2015 performance targets may also be explored. Novel engineering concepts may include novel components, novel approaches to thermal management, conceptual engineering designs, safety investigations, or environmental impact investigations. Results to be reported to DOE should include the results of feasibility studies, conceptual designs with projected performance characteristics in comparison to the DOE targets, or the results of safety or environmental impact investigations as appropriate for the individual project.

Phase 2 is intended to expand the conceptual designs and/or feasibility studies from Phase 1 to include additional simulation, bench-scale experimental testing if applicable, and estimates of weight, volume and cost. The primary Phase 2 objectives are to demonstrate that the novel engineering concept will enable hydrogen storage systems to meet the 2010 performance targets and to show potential to meet the 2015 performance targets. Results to be reported to DOE should include design and simulation results with performance characteristics in comparison to the DOE targets, bench-scale testing results, or the results of safety or environmental impact investigations as appropriate for the individual project. Estimates of weight, volume, cost, and other performance characteristics (such as thermal management required during charging and discharging) should also be reported to DOE.

Topic 2 projects may include bench-scale component testing as required to assess the feasibility of a novel concept. However, Topic 2 projects are not intended to include construction or testing of complete prototype hydrogen storage systems.

**Cost share requirements for Topic 2:**

Applicants must contribute a minimum of 20% cost share (of the total project cost).

**Topic 3: Systems, Safety and Environmental Analyses**

Applications are sought under Topic 3 for technical feasibility, environmental and economic analyses that compare and contrast various emerging on-board hydrogen storage technologies. Applications focusing on safety analyses of competing technologies are also sought under Topic 3. Examples include cradle-to-grave or life cycle analyses, including but not limited to, energy



efficiency, environmental impact, life cycle cost and emissions analyses. Topic 3 is for analyses only and does not include laboratory work.

**Objective for Topic 3:**

The primary objective of Topic 3 is to investigate and document life-cycle cost, energy efficiency, environmental impact, and safety of different on-board storage options. Analyses should include the effects of cost and performance trade-offs. Results to be reported to DOE should include systems analyses of energy efficiency, life-cycle costs, emissions, safety, and environmental impacts of various on-board storage options. Rather than focusing on one specific material, the intent of this topic is to provide analyses for classes of materials or chemistries across various options for on-board hydrogen storage.

**Cost share requirements for Topic 3:**

No cost sharing is required for projects under Topic 3.